Comments on Certain Recent Generalizations Regarding Cleaning Symbiosis in Fishes

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MANY FISHES in the marine environment remove ectoparasites, diseased tissue, and other deleterious material from the bodies of other aquatic animals (Eibl-Eibesfeldt, 1955; Randall, 1958; Limbaugh, 1955; and others). In reporting on these "cleaners," Limbaugh (1961), in a posthumous report edited by Howard M. Feder, attempted some broad generalizations that contrast cleaning in tropical and temperate seas; these were later presented by Feder (1966) in his review of cleaning symbiosis in the marine environment. These generalizations are in need of critical review, as they are now becoming entrenched in the literature (e.g., Gotshall, 1967; Marshall, 1965; Ommanney, 1966).

In reviewing available information on cleaning symbiosis, one must guard against bias when considering distinctions between the tropical and temperate situations. Many more observations have been made in warm, clear tropical waters than in the colder, more turbid waters of higher latitudes, where data are limited almost entirely to the warm-temperate region. Observations from the cold-temperate and arctic regions are essentially nonexistent. Nevertheless, adequate data are available to test the validity of the generalizations considered in this paper.

My comments apply only to the inshore waters of the eastern Pacific, where I made observations between 1961 and 1968, mostly incidental to other work. During this period, observations involving more than 1,500 hours under water were made in the warm-temperate waters of California and in the tropical waters between the Gulf of California and the Galapagos Islands. Significantly, most of the observations on which Limbaugh (1961) based his generalizations were made within this same part of the eastern Pacific.

Generalization I: Tropical cleaners are not gregarious, living solitarily or in pairs, whereas temperate zone cleaners are usually highly gregarious or schooling (Limbaugh, 1961, p. 45; Feder, 1966, p. 338)

This generalization is invalid in the eastern Pacific, where many tropical cleaners are highly gregarious. Consider, for example, the butterflyfish *Heniochus nigrirostris* Gill. In regard to the cleaning habits of this species, Feder (1966, p. 340) stated: "The butterflyfish are always paired, and all prominent rocky points are occupied by at least one pair of adults." The fact is, cleaning stations maintained by *H. nigrirostris* usually include a large number of individuals, sometimes several hundred (Fig. 1).

Feder (1966) also cited, without indicating size or age, cleaning habits in *Thalassoma lucasanum* Gill, apparently unaware that this is probably the most gregarious wrasse in the tropical eastern Pacific. In this species, however, the adult cleans rather infrequently; the small juvenile, on the other hand, does have well-developed cleaning habits and tends to be solitary. This fact is consistent with the generalization that tropical cleaners are solitary or paired. However, just the opposite situation occurs in another tropical wrasse, *Bodianus diplotaenia* Gill. In this species, which attains a large size, the noncleaning adults are solitary, or swim in groups of two or three, whereas the cleaning juveniles frequently swim in aggregations of a dozen or more.

Among the damselfishes, Feder (1966) reported cleaning by juveniles of *Macrospathodon* sp. I have not seen cleaning by members of this genus, but did observe cleaning by the gregarious *Abudefduf troschelii.*

Nor can one generalize that cleaners in the colder waters of the eastern Pacific form large aggregations or schools. This contention seems to have been based primarily on habits of the señorita, *Oxyjulis californica* Günther, which

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FIG. 1. Cleaning station maintained by *Heniochus nigrirostris* in the Gulf of California. Over a period of six years (1962–1968), this aggregation was always present when observations were made at this location.

frequently swims in large schools. Feeding as it does on a wide variety of benthic organisms, the señorita is not particularly specialized as a cleaner. Yet, by virtue of its great abundance, it is the predominant cleaning fish in the kelp forests and other rocky inshore habitats.

Citing observations at Monterey, California, Gotshall (1967) reported a school of 20 to 30 small rainbow seaperch, *Hypsurus caryi* (Agassiz), 80 to 100 mm long, cleaning *Mola mola* (Linnaeus). He also described 15 to 20 of what he thought might be sharpnosed perch, *Phanerodon atripes* (Jordan and Gilbert), cleaning a mola in midwater after rising from the rocks below. Gotshall felt that these observations supported the generalization that colder water cleaners are gregarious, but one may question the assumption that fishes drawn together at a common feeding site are necessarily gregarious.

Limbaugh (1955, p. 88) stated that *Hypsurus caryi* is "solitary, occasionally forming groups of two or three." I have generally found *H. caryi* in small groups of two to six, although my observations are largely limited to individuals longer than about 125 mm.

I have not found juveniles of *Phanerodon atripes* at La Jolla to be gregarious, although they are the most highly specialized cleaners I have observed off California. To my knowledge, these relatively deeper-water fish do not often enter the kelp forests or other shallow-water communities, at least in southern California. In one location, at a depth of 80 feet, juvenile sharpnosed perch are the most active cleaners, even though señoritas are far more abundant in the immediate area. These perch are solitary (Fig. 2), or, less frequently, swim in groups of two or three. During one period of observations (February to April, 1968) water temperatures at this location ranged between 49° and 52° F, supporting the contention that this is a colder-water fish. They clean mostly close to the rocky bottom, but occasionally they rise as far as 15 feet from the substrate to service a client. The stomachs of these perch often are filled with caligid copepods exclusively; I have never seen

FIG. 2. A group of *Chromis punctipinnis* soliciting cleaning from a solitary *Phanerodon atripes* at a depth of 80 feet off La Jolla, California.

stomach contents of a señorita, or any other California cleaner, with a similar preponderance of ectoparasites or other evidence of cleaning. Clarke et al. (1967) observed *P. atripes* cleaning a rockfish (*Sebastodes* sp.) at a depth of about 190 feet off La Jolla.

The other cleaners reported among California fishes by Limbaugh (1955) and Feder (1966) are the kelp perch, *Brachyistius frenatus* Gill; the pile perch, *Rhacochilus vacca* (Girard); and the blackperch, *Embiotoca jacksoni* Agassiz (as the oceanic blackperch, *Embiotoca* sp.). All are members of the family Embiotocidae.

The kelp perch is gregarious, occurring in scattered aggregations of a dozen or more just below the surface canopy of the kelp forests. However, Limbaugh (1955, p. 86) has described the blackperch as living "usually as solitary individuals or groups of three or four," and I have also found this fish usually to be solitary. Furthermore, Feder (1966) stated that cleaning occurs in pile perch only among juveniles, and Limbaugh (1955, p. 90) stated that "the subadults tend to be solitary."

Generalization II: Tropical cleaning species are more numerous than those in temperate waters, but the number of individuals is less (Limbaugh, 1961, p. 45; Feder, 1966, p. 338)

True, there are more known cleaning species in tropical waters, but one should not assume this is necessarily related directly to the cleaning habit. After all, tropical seas include a greater number of non-cleaning species as well. It remains to be determined whether or not cleaning species are proportionally more abundant in the tropics.

As far as relative numbers of individuals are concerned, the validity of this generalization also seems highly questionable. Of the known cleaners in California waters, only the señorita is especially abundant inshore. Among the tropical cleaners, *Heniochus nigrirostris* is very abundant in some parts of the Gulf of California,

and *Thalassoma lucasanum* and *Abudefduf troschelii* are extremely abundant throughout the tropical eastern Pacific. All these cleaners are probably more numerous than any of the known California cleaners, with the possible exception of the señorita.

Generalization III: In comparison with the temperate region, tropical cleaners more nearly approach the condition of full-time cleaners, and receive a larger portion of their food this way (Limbaugh, 1961, p. 45; Feder, 1966, p. 338)

Many cleaners in the tropical eastern Pacific only infrequently engage in this activity. Probably *Heniochus nigrirostris* comes as close as any to being a full-time cleaner, and this butterflyfish obtains much of its food from other sources. The tiny gobies *Gobiosoma digueti* (*Pellegrin*), and *G. puncticulatum* Ginsberg are cleaners, and though data are presently lacking, either one or both may be highly specialized. Perhaps some of the juveniles approach being full-time cleaners, notably very young *Bodianus diplotaenia, Thalassoma lucasanum,* or *Holocanthus passer* Valenciennes. Here again, however, I am mostly speculating on the basis of the frequency with which these juveniles "pick" at the bodies of other fishes. In any event, juveniles of *Phanerodon atripes* of California, discussed above, seem to be as highly specialized as any cleaner in the tropical eastern Pacific.

One might expect that, with the greater number of species present, there would be more highly specialized cleaners in the tropics. If species of the Indo-west Pacific genus *Labroides* are as specialized as reports indicate (e.g., Randall, 1958), one might properly say that the most highly specialized cleaners occur in the tropics, but this is quite different from the general statement that tropical cleaners are more specialized.

Generalization IV: Tropical cleaners put on elaborate displays in connection with their cleaning activity that are similar to the mating displays of male fishes (Limbaugh, 1961, p. 45; Feder, 1966, p. 338)

To my knowledge, no cleaner in the eastern Pacific performs displays of this sort in association with its cleaning activity. Although Feder (1966) made this generalization, he cited such activity only for species of *Labroides*. There seems to be no basis for attributing activity of this sort to tropical cleaners in general.

Generalization V: Cleaners in tropical waters are more brightly colored, and more contrastingly marked than those in temperate waters (Limbaugh, 1961, p. 45; Feder, 1966, p. 338)

True, but as with the relative numbers of species in the two regions, this generalization probably reflects the general characteristics of the respective faunas more than any factor associated directly with cleaning activity. Fishes in the tropics tend generally to be more colorful than those in the temperate regions. Brightly colored cleaners belong to groups that also include other brightly colored species that are not cleaners (e.g., Labridae, Pomacentridae, Chaetodontidae, and others). Limbaugh (1961, p. 45) stated, ". . . it appears that most fishes that stand out in their environment are cleaners." The fact is, non-cleaning, brightly hued fishes that stand out in their environment are legion. In addition to non-cleaning species in the groups cited above, there are highly colorful, non-cleaning species among the Scaridae, Acanthuridae, and many other families.

Intuitively, one would expect cleaners to benefit from being in sharp contrast with their surroundings, as they would then be more readily recognized by the species with which they interact; certainly the more highly specialized tropical cleaners seem to be especially colorful. Nevertheless, evidence supporting a direct relationship between bright coloration and cleaning is still weak.

Although cleaners in the colder California waters do not particularly stand out in their surroundings, a trait they share with most fishes in their environment, several California species not known to be cleaners are highly conspicuous. A notable example is the bright-orange garibaldi, *Hypsypops rubicunda* (Girard)—unquestionably the most conspicuous fish in its habitat, if not in the entire inshore eastern Pacific. Nor have cleaning habits been reported in the brightly hued, blue-banded goby, *Lythrypnus dalli* (Gilbert). This little fish is very conspicuous on rocky substrates where it occurs.

Generalizations of the type attempted by Limbaugh are extremely valuable in providing insights into natural phenomena. However, one should have a foundation of data that is as broad as the scope of the generalizations; in this instance the generalizations seem unwarranted. Limbaugh, as much as anyone, has provided the critical raw material from which generalizations on cleaning symbiosis can be made, but much additional information is required before one can confidently contrast the situation in warm tropical seas with that in colder waters of higher latitudes. Of particular need are data from the cold-temperate and arctic regions.

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